

Amendments to the Specification:

Please replace paragraph [0006] with the following amended paragraph:

[0006] Another type of hydrogen generation system employs a chemical hydride solution. In this system an aqueous chemical hydride solution is introduced to a catalyst bed to generate hydrogen. However, there are a number of problems associated with this liquid ~~phased~~ phase system. First, the by-product borate, in the above equation, NaBO_2 is less soluble than the reactant borohydride, namely NaBH_4 . Specifically, NaBO_2 is only approximately 20% soluble. This means that in order to generate hydrogen in a liquid phased system, and thereby reduce the problems associated with the aforementioned solid phased systems, the concentration of borohydride in the solution can only be about 20% which is much lower than borohydride's solubility in water. Therefore the achievable hydrogen density of the system is considerably limited.

Please replace paragraph [0030] with the following amended paragraph:

[0030] Preferably, the operation of continuously introducing water into the hydride tank 5 is achieved by recycling of the water entrapped in the fuel cell exhaust and supplying the water to the hydride solution. As shown in figure 1, water is generated on the cathode of the fuel cell stack 3 and is exhausted from the fuel cell stack 3 together with the unreacted air. The exhaust mixture of air and water then flows to a gas-liquid separator 16 in which air and water are separated. Therefore, the water is recovered. The recovered water is then introduced through a recovered water line 12, that provides a delivery mean for the water, into the chemical hydride solution in the storage tank 5. As water is a by-product of the fuel cell reaction, the hydrogen generation system utilizes the readily available water in its vicinity, resulting in increased system efficiency. Generally, recovery of the exhaust water can enable the initial concentration of the hydride to be increased by at least 50%, as is demonstrated in the following tables.

Please replace paragraph [0031] with the following amended paragraph:

[0031] Table 1 and table 2 respectively show the composition of NaBH_4 , water and NaBO_2 in the solution during hydrogen generation reaction, for a conventional solution and for a solution in accordance with the present invention, in which the water is added as the reaction progresses. The initial concentration of NaBH_4 in both tables is 40%, that is to say, 400g NaBH_4 in 1 L water. As the experimental data show, the conventional solution begins to clog when there is 300g of NaBH_4 left in the solution. This is because the concentration of NaBH_4 is close to the initial 20% level, and exceeds this when the level of NaBH_4 has fallen to 250g. The solution of the present invention (Table 2) only begins to clog when 250g of NaBH_4 is left in the solution. Again, the table indicates that the critical 20% level for NaBH_2 is exceeded just before the amount of NaBH_4 falls to 250g. It is clear that the present invention considerably increases the hydrogen generation capacity of NaBH_4 water solution. The data shows that, by adding exhausted water, one can reduce the concentration of NaBO_2 effectively enabling the NaBH_4 level to be reduced further before clogging occurs. Table 1 shows, as expected due to utilization of H_2O to generated hydrogen, that the amount of H_2O reduces by over one third at the end of the experiment. Table 2 shows, due to the addition of the exhaust water, that the total volume of water increases to close to 1400 g. and is at 1142.90 grams of at iteration 3. This would require the tank 5 to have a larger volume. However, the initial amount of NaBH_4 is increased by 50g, that is 1/6 more than that in conventional systems. The increase of water happens only as the reaction continues. In this example, the amount of water is only increased by approximately 1/10, which means the recovery of water still has the effect of increasing the energy density of the overall system.

Please replace paragraph [0032] with the following amended paragraph:

[0032] Since the reaction in the reactor 20 is exothermic, necessary cooling means has to be provided. Generally, cooling tubes can be provided within the reactor

20 in which a cooling fluid flows through. As shown in figure 1, in the present invention, the coolant for the hydrogen generation reaction can be water or other commonly used coolants for the fuel cell stack 3. Coolant enters the reactor 20 via a coolant inlet thereof from the coolant line 13a, flows through the coolant tubes in the reactor 20 and leaves the reactor 20 via a coolant outlet, taking away the heat generated in the reactor 20. Then the coolant returns to a coolant storage tank 4 by a the coolant line 13b and is circulated to the fuel cell stack 3. Generally, a heat exchanger 14 is provided in the coolant line 13 before or after the coolant reaches the fuel cell stack 3 to maintain the coolant at a low temperature. Then the coolant flows through the fuel cell stack 3 and then into the reactor 20 and continues to circulate in the coolant loop. The heat exchanger 14 can in principle be located at any location in the coolant loop ~~loop~~.

Please replace paragraph [0033] with the following amended paragraph:

[0033] In operation, the fuel cell stack 3 generates electricity while consuming the hydrogen supplied from the reactor 20. In order to provide the hydrogen generation system with the load following ability, a pressure sensor 18 is provided at the hydrogen outlet of the reactor 20. The pressure sensor 18 is in connection with a switch 24 in hydride supply line 22 and controls the operation of the same, and the switch 24 controls the pump 26 pumping the solution from the tank 5 to the reactor 20. The hydride supply line 22, the switch 24 and the pump 26 together provide a supplying device, while it will be recognized that not all these elements are always essential. As the reaction in the reactor 20 continues, the hydrogen is generated and supplied to the fuel cell stack 3. However, when the fuel cell stack 3 operates in a condition that the hydrogen generation rate in the reactor 20 is more than the hydrogen consumption rate of the fuel cell stack 3, the pressure of hydrogen in the reactor 20 increases until it reaches a certain value when the pressure sensor 18 activates the switch 24 to shut down the pump, and hence cut the hydride supply to the reactor 20. Therefore the reaction in the reactor 20 stops. Then the fuel cell stack 3 continues to consume the hydrogen, resulting in the pressure drop of hydrogen in the reactor 20 until it reaches a

certain value when the pressure sensor 18 controls the switch 24 to start the pump 26 and hence the hydride solution is supplied to the reactor 20 and in turn hydrogen is generated to meet the demand of the fuel cell stack 3. Thus the system of the present invention has the capability to follow the load as well as meet peak performance requirements. Additionally, when the fuel cell stack 3 shuts down, the pressure sensor 18 will immediately activate the switch 24 to shut down the pump 26. The reactor 20 preferably has a vent (not shown) so that the hydrogen present in the reactor at the time of shutdown and that generated thereafter can be released, either into the environment or a storage device. Hence the system can shut down completely in a relatively short time. Figure 3 illustrates the hydrogen flow of the present system during operation at a constant rate, employing the said pressure sensor 18 and the switch 24. As illustrated, the hydrogen flow is stable throughout the operation. It is to be understood that the drop of the hydrogen flow in the curve indicates the process of system shutdown. ~~[For instantaneous shutdown, is there any need to provide a vent or release valve for residual hydrogen, present and generated after shutdown?]~~

Please replace paragraph [0036] with the following amended paragraph:

[0036] Preferably, the chemical hydride solution further includes alkaline additives, such as LiOH, KOH, NaOH to provide an alkaline condition which significantly slows the chemical hydride reaction, thereby lengthening the shelf life of the solution. NaOH is mostly used due to its relatively low mass and cost. A concentration of 0.1% NaOH is adequate in raising the PH pH enough to stabilize the solution.

Please replace paragraph [0037] with the following amended paragraph:

[0037] For NaBH₄, another additive, namely LiBH₄ may be added into NaBH₄ solution. This lighter material has a much higher hydrogen density than NaBH₄. However, the by-product of LiBH₄ and water reaction, LiBO₂, only has a solubility of 5% and the reaction of LiBH₄ with water is much slower than that of NaBH₄ and water.

This means an addition of less than 5% LiBH_4 to the NaBH_4 solution will increase the hydrogen density of the solution without causing precipitation of the said by-product and without significantly affecting its load following ability. Figure 6 shows the comparison of NaBH_4 solution and LiBH_4 - NaBH_4 solution. The generally lower reaction rate and slow rise in temperature indicate that the mixed solution is more stable than pure NaBH_4 .

Please replace paragraph [0040] with the following amended paragraph:

[0040] In this embodiment, hydrogen enters the fuel cell stack 3 from the hydrogen outlet of the reactor 20. Preferably, a filter ~~26~~ 27 is provided in the hydrogen line 11 before the hydrogen enters the fuel cell stack 3 to remove fine aerosol particles in solution, catalyst and other particles (and this filter can be included in the first embodiment of Figure 1). As is known to those skilled in the art, a considerable portion of both air and hydrogen supplied to the fuel cell stack 3 does not react. Rather, the excess hydrogen and air leave the fuel cell stack 3 through the anode and cathode outlets thereof, respectively. Therefore, it is preferable to recirculate the excessive hydrogen back to the fuel cell stack 3 for reaction. For this purpose, a hydrogen recycle loop 15 and a catalytic burner 2 are provided in this embodiment. As shown in figure 2, a valve 9 and a centrifugal pump 19 are provided respectively at the two ends of the hydrogen recycle loop 15. Specifically, a centrifugal pump 19 is provided at the junction of the hydrogen recycle loop 15 and the hydrogen line 11 between the reactor 20 and fuel cell stack 3, and a valve 9 at the junction of the hydrogen recycle loop 15 and the hydrogen line 11 between the fuel cell stack 3 and the catalytic burner 2. When the fuel cell stack 3 is in operation, the pump 19 operates continuously, creating a negative pressure to ensure the hydrogen generated in the reactor 20 continuously flows from the reactor 20 to the fuel cell stack 3 via the hydrogen line 11. Excessive hydrogen flows through the anode outlet 10 of the fuel cell stack 3 to the valve 9. The said valve 9 is in a position that closes the hydrogen line 11 from the anode outlet 10 to the catalytic burner 2, thereby forcing the hydrogen to flow along the hydrogen recycle loop 15 and back to the fuel cell stack 3 for reaction by means of the pump 19. On a periodic basis,

the valve 9 is turned to an open position so that the excess hydrogen flows to the catalytic burner 2. As can be seen in figure 2, the exhaust of the fuel cell from the cathode thereof also flows into a catalytic burner 2 along the respective line 17 thereof after leaving the fuel cell stack 3. In the catalytic burner, the hydrogen and the oxygen in the exhaust of the fuel cell react in the presence of an appropriate catalyst to form water in the known manner, i.e. $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$. Then the mixture of water and unreacted exhaust of the fuel cell flows from the catalytic burner 2 into a water recovery unit 1 which may be a gas-liquid separator. The water is separated from the mixture and circulates to the hydride storage tank 5. Recognizing that there will usually be an excess of air or hydrogen, an exhaust 8 is provided for venting residual gas into the environment from the water recovery unit 1. In practice, the opening of the valve 9 to let hydrogen flow to the catalytic burner 2 may be controlled by a controlling means, for example a timer (not shown). The opening of the valve 9 also prevents the fuel cell stack 3 from flooding due to the accumulation of water generated in the fuel cell reaction. The interval of opening valve 9 may be varied in various operation conditions and optimized by experiments.

Please replace paragraph [0042] with the following amended paragraph:

[0042] It is anticipated that those having ordinary ~~skills~~ skill in the art can make various modifications to the embodiments disclosed herein after learning the teaching of the present invention. For example, the number and arrangement of components in the system might be different, different elements might be used to achieve the same specific function. However, these modifications should be considered to fall under the protection scope of the invention as defined in the following claims.